USE OF THE FUNGICIDE BAYLETON® (TRIADIMEFON) IN THE PREVENTION OF WHITE PINE BLISTER RUST.

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INTRODUCTION

White pine blister rust (*Cronartium ribicola*) is an introduced disease capable of infecting virtually all white pine species, including our high-valued eastern white pine (*Pinus strobus*) (Hoff *et al.* 1980). The fungus typically enters trees through foliar stomata and grows down through the vascular tissue of the needles into the cambium of the branch or stem. Infection sites are characterized by a weeping canker that eventually causes girdling and death of affected extremities. Little natural resistance to the disease and high incidence of deformation and mortality make blister rust a serious threat to the regeneration of white pine.

A systemic fungicide capable of protecting white pine from blister rust infection could be a valuable addition to an integrated pest management program for this species. Bayleton® (triadimefon) is a systemic fungicide registered in the U.S. for the control of fusiform rusts on pine seedlings. In previous studies, this fungicide has proven effective as a foliar treatment for preventing blister rust infection on sugar pine (*Pinus lambertiana*) (Johnson *et al.* 1992) and white pine seedlings (Bérubé 1996). The hypothesis tested in this investigation is that a triadimefon slow-release tablet, placed in the ground with the seedling at the time of planting, could serve as a prophylactic against blister rust infection during the tree's establishment and early growth phases (1-4 years). The following paragraphs summarize the efficacy results of 3 independent field trials involving use of the fungicide triadimefon in tablet form.

METHODS

For the purpose of the field trials described below, Vigoro Industries Inc. formulated a special lot of 21-g tablets in 1993. Tablets were manufactured with one of 4 rates of triadimefon (0, 1000, 2000, or 4000 ppm), in combination with one of 3 rates of the systemic insecticide Merit® (imidacloprid) (0, 1, or 2 g a.i.), either with or without fertilizer (N-P-K = 15-8.5-3.75). The insecticide was included for the purpose of studying potential influences on the efficacy of the fungicide and fungicide-fertilizer combinations, although its operational intent would be the prevention of attack by the white pine weevil (*Pissodes strobi*).

Two field trials were established that included the full suite of 24 tablet treatments (4 rates of triadimefon × 3 rates of imidacloprid × 2 rates of fertilizer), plus an untreated control (no tablet with planting). The first, located near Temagami, Ontario, was established in spring 1993 following a clearcut harvest on relatively coarse-textured soils. The second was established a

year later, following a partial harvest on medium-textured soils near Sundridge, Ontario. The 25 treatments were each assigned to rows of 5 planting locations, in a completely randomized design (Temagami) or a randomized complete block design (Sundridge), with 10 replications of each treatment. Container (Multipot 45) and bare-root (3+0) seedlings were planted at the 2 sites, respectively, with or without tablets appropriate to the assigned treatments. At the end of 7 consecutive growing seasons following treatment and planting, each seedling was assessed for height, root-collar diameter, and incidence of main-stem or branch blister rust infections. At the end of the 1st, 3rd, 5th, and 6th growing seasons, chemical residue analyses were conducted on foliage samples taken from each treatment to quantify levels of triadimefon and its active metabolites (triadimenol A and B) in the seedlings.

A third field trial involved just 8 of the 24 treatments (triadimefon at 0 or 4000 ppm, imidacloprid at 0 or 2 g a.i., each with and without fertilizer) and was established just north of Sault Ste. Marie, Ontario, in 1998. A pure tolerant hardwood forest had been shelterwood harvested in 1997, leaving a range of canopy openings. Each of the 8 treatments was randomly assigned to 5-tree planting locations within 5 blocks that encompassed a range of hardwood canopy openings (10% to 60%). Container (Multipot 67) seedlings were planted and assessed, as described for the other two installations, excluding foliar residue analyses. In contrast to the 2 previous trials, non-crop vegetation on the Algoma plots was controlled annually with directed foliar applications of glyphosate.

For each of the 3 trials, mortality, infection levels, and growth were used as response variables in analyses of variance (ANOVA). Orthogonal contrasts were used to assess fungicide dose response (e.g., linear, quadratic, etc.), as well as the various interactions between the three factors (fungicide, insecticide, and fertilizer).

RESULTS

Each of the 3 field trials reflects different levels of white pine blister rust pressure. At the Temagami and Sundridge sites, mortality of unprotected trees increased steadily over time, approaching 70 and 90%, respectively, by the end of the 7th growing season. In contrast, mortality in untreated trees at the Algoma site was less than 15% by the end of the 5th growing season. Despite these differences, all three sites exhibited significant reductions in seedling mortality associated with triadimefon treatment ($p < 0.01$). Efficacy tended to increase between doses of 1000 and 2000 ppm, with little difference observed between the 2000 and 4000 ppm rates. With doses of 2000 ppm or more, mortality averaged 34 and 48% after 7 growing seasons at Sundridge and Temagami, respectively, and 3% after 5 growing seasons at Algoma.

Fertilization tended to enhance the efficacy of triadimefon treatment at the Temagami site, regardless of the year of assessment ($p < 0.03$), resulting in additional mortality reductions between 2 and 18%. Sundridge, considered a more nutrient-rich site than Temagami, exhibited differences associated with fertilization until year 5 ($p = 0.02$), but not thereafter ($p = 0.33$). Fertilization did not have any effect on mortality at the Algoma site ($p > 0.18$), perhaps because rigorous weed control efforts reduced competition for moisture and nutrients there. The addition of a systemic insecticide (imidacloprid) had no influence on the efficacy of triadimefon at any of the 3 sites ($p > 0.40$).

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In surviving trees, triadimefon reduced the incidence of main-stem blister rust infections through 4 growing seasons after treatment at all sites ($p < 0.01$). Beyond the 4th growing season, it is evident that the effect of the fungicide treatments diminished, with infection incidence increasing to similar levels observed in untreated trees by the end of the assessment period. This is consistent with observed mean triadimenol residues in the foliage, which peaked 3 growing seasons after treatment, at 2 ug/g fresh weight of foliage, and dropped off to about 0.2-0.3 ug/g fresh weight of foliage through seasons 5 and 6. The percentage of healthy uninfected trees at the end of the assessment period increased with triadimefon dose, through to the maximum rate tested. The percentage healthy, uninfected trees receiving the 4000 ppm rate were 33-35% at Temagami and Sundridge, and 62% at Algoma.

Triadimefon treatment generally did not affect white pine growth ($p > 0.05$). After 5 growing seasons, Algoma trees averaged 155 cm in height and 36 mm in basal diameter (stem volume index = 1884 cm^3). At the same age, Sundridge trees averaged 127 cm × 26 mm (932 cm^3) and Temagami trees only 85 cm × 19 mm (318 cm^3), their smaller sizes most likely due to a lack of weed control on these sites.

TAKE-HOME POINTS

- White pine blister rust severity varies from site to site, causing between 14 and 80% mortality by age 5.
- Use of triadimefon fungicide, as a slow-release tablet applied at the time of planting, reduced mortality and the incidence of blister rust infection through 4 growing seasons. Additional treatments may be necessary to reduce infection incidence beyond year 4.
- Fertilizer may enhance triadimefon efficacy, particularly where nutrients are limiting.
- Imidacloprid had no influence on triadimefon efficacy.
- Complete white pine regeneration success may be unlikely without an integrated pest management approach that considers a variety of preventative measures, including genetic improvement, low-hazard site selection, use of healthy, vigorous planting stock, adequate weed control, and pruning.

REFERENCES

Bérubé, J.A. 1996. Use of triadimefon to control white pine blister rust. For. Chron. 72(6): 637-638.

Hoff, R., R.T. Bingham, and G.I. McDonald. 1980. Relative blister rust resistance of white pines. Eur. J. For. Path. **10**: 307-316.

Johnson, D.R., B.B. Kinloch, and A.H. McCain. 1992. Triadimefon controls white pine blister rust on sugar pine in a greenhouse test. Tree Planters' Notes **34**(1): 7-10.

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